

Construction Challenges of Bridges in Hilly Area

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Abstract— Himalaya since Vedic times have been considered a vast repository of valuable medicinal herbs, minerals, forest resources etc. Vedic literature followed by the writings of Charaks, Susruta, Dhanwantri, Nagarjuna, Parashar, Balmiki and various other saints, bear testimony to it. "Alexander, The Great", who was much influenced because of its scenic beauty, bracing climate and agroclimatic conditions, made a great publicity of the Himalayan Herb Science in Yunan and Rome during middle ages (Anonymous, 1977; Chauhan, 1988). This potential, however, remained unexploited especially in higher reaches due to inadequate means of communication. After independence, Govt. of India, gave a special emphasis on road construction in order to bring socio-economic upliftment of tribal inhabitants. But due to lack of proper planning it resulted in serious ecological imbalances. Society has now become aware of the environmental consequences resulting from road construction in hill areas. Right from the days of Vedas, our country has an age-old tradition of environment consciousness. During Samrat Ashok's days social forestry was at its full swing having shady trees along the roads and fruit plants on the wastelands. In this paper efforts have been made to incorporate the latest techniques for protecting the environment after extensive survey of literature (Lone et al., 1992 and Chauhan.

Keywords: Critical Path Method (CPM), Superstructure, Deforestation

I. INTRODUCTION

Hilly region pose unique problem for bridge construction. In a restricted hilly area itself climatic conditions, geological features and hydrological parameters vary considerably. Keeping in view the bridge site and various constraints, type of bridge and method of construction are to be selected carefully for safe, economical and successful completion of bridge construction.

Various challenges that come across while constructing bridges in hilly area are

- 1) Construction of bridge across deep gorges
- 2) Construction of bridge on rivers with boundary beds
- 3) Construction of bridges in extreme temperature zones
- 4) Construction of bridges on sharp turn on highway
- 5) Landslide or Debris flow

Deep gorges, rivers with boundary beds, extremely low temperature condition, high winds, landslide etc. in hilly regions require special attention to complete the activities of bridge planning and construction in a systematic way and are discussed here in.

II. BRIDGE CONSTRUCTION OVERVIEW

Planning and monitoring is basically what is to be done in due course of time, and how it is to be executed in the planned/allotted period for the particular bridge. All the pros and cons of the likely problems in the anticipated period need

to be examined. Also the records of important points are made available at site with executives as follows:

- Why the particular site was selected for the bridge.
- Why particular type of bridge is proposed. (structural arrangement)
- Site data
- Proposal for preparation drawing.
- Soil strata in the form of bore log.
- Model study detail if already done for scour assessment.
- Salient features of the bridge and quantities of each items involved.
- Upto date approved structural drawings.
- Details of all meetings and up to date decision if at all taken.
- Decision making mechanism in case of any dispute i.e. Dispute Review Board (DRB) be already finalized

III. BRIDGE FOUNDATION AND SUBSTRUCTURE

Foundation construction for any large bridge takes time. Problems encountered during construction of foundation depend upon type of foundation, soil strata encountered, equipment/plant deployed and logistic problems. Construction difficulties anticipated during the execution be kept in view while planning the works/ period for the job. Foundation can be opened foundation, pile foundation, well foundation or any other types of foundation. In case of well foundation, the various type of soil are encountered and it becomes difficult to give any clear time schedule about the sinking of wells unless the soil details are very clear and the anticipated profile matched with the actual encountered. In case of bouldery and clayey soil the rate of sinking schedule is likely to be slow when compared with the sandy soil. Also there may be requirement of pneumatic sinking technique subsequent to open grabbing due to difficulties in sinking of well.

As the cost of pneumatic sinking is very high, this should be deployed judiciously. In such cases, there is need to keep the details of all the sinking difficulties in a systematic order and this can be reviewed in consultation with decision making authority. Review of soil parameter if required be given more attention and wherever required the details may be referred to material testing laboratory but within the time schedule. This may be helpful to recommend revision in foundation level, wherever possible based on soil data report. Tough strata in the foundation stage should be considered as engineering friendly

IV. SUPERSTRUCTURE

For particular site there are numerous structural arrangements possible. Final proposal be made based on the greater examination of site condition may be technical, aesthetic and construction methodology. Special care need to be taken in case of deep gorge where there is sizable difference between

soffit level and bed level. This may pose difficulties for staging and shuttering. Proposal recommended for site should be well read in advance. After the proposal has been finalized for particular bridge, the construction can be planned. The quantities of each items involved and execution method be listed. Basically method statement should be kept ready for overall execution including job estimate. This data will be kept to ensure smooth progress of project.

V. MANAGEMENT OF CONSTRUCTION ACTIVITIES

Management of bridge construction demands that construction manager to reorient all the resources in such a way that the project is completed without any time/cost overrun. Output of the work depend upon how best the activities are managed which will vary from site to site based on many factors. Based on the experience, various aspects be identified for efficient construction management. Schedule of construction based Critical Path Method (CPM) be prepared along with major milestone and Bar Charts.

Latest software management tool can be used for this in case of a major bridge project. Design of Bridge is a post sanction in case of departmental construction and after tendering action in case of bridges throughout contract. It is necessary that design must be preceded by at least six to eight months or say 50% ahead of execution of concerned event. It has to be ensured that this should be completed well in time. Revised design if any should be updated and clarified without delay. Observation on the approved design drawing if any be passed to design office immediately to make the changes. This is most important in case of foundation where design soil parameter needs to be adhered to. These may vary on actual execution and require review of design. To keep details with design office it is necessary that progress of foundation work be well informed to the design office.

A. Plant Management

Requirement of equipment/plant be assessed systematically and accordingly action may be taken to arrange this for a particular job.

- Quantum of work covering all the items with specifications
- Time available for work execution Details of equipment and also minimum requirement as per job position.
- Rated capacity of equipment/ plant
- Assessed capacity
- Schedule of maintenance
- Inventory of spare parts required
- Repair cover to equipment/plant

The layout should ensure minimum movement of material, equipment and personnel of the area is an essential condition, for operation of some equipment for example tower crane operation not possible at heavy winds speed. Stone crusher if required for site should be suitably located. Supporting facilities such as generator, office, stores should not be located in the path of dust, flow. The service road should be properly maintained. Receipt and dispatch of equipment be kept in proper format to keep of details of its utilisation at site. After staff has reported at site necessary action should be taken to utilise all the equipment. The

required facilities for servicing and repair must be established to meet requirements.

B. Material Management

Material management is a parallel activity along with start of the Project. This cover procurement of camp material, office equipment, major purchased items, such as aggregates, sand, cement, steel, structural steel, shuttering consumables, electrical fittings. Forecasting of quantities and cost of various items on monthly basis must be done at least three to six months in advance which should be regularly reviewed.

C. Finance Management

No project or project management can be meaningful without this. In case of Government work the manager should get his budget fixed on monthly basis, on the basis of work done or minimum to be fed at site, on the decision of higher authorities. Key to measure financial planning lies in taking all above action and taking suitable measures at appropriate times to ensure that individual inputs are achieved to the maximum and capital investment kept at the lowest level.

D. Quality Management

Quality of work at site is most important activity and manager should always grapple to improve the same. Training to staff should be provided to update the quality control measure and it should become part of the work culture. At site laboratory be established to check the quality of concrete. Tests be analysed at site based on the size of job. Mix design should be prepared based on the latest code and to produce the concrete of desirable strength. Compaction of concrete be given more attention before final setting. Latest guidelines issued by IRC and MORT&H be followed for systematic quality assurance. Quality assurance on ground improve the aesthetic of structures.

E. Safety Management

Safety of employees at site should be observed very seriously. All the workers be given briefing about the safety requirements based on the site hazards. Especially when the simply supported structure is attempted on deep gorge, suitable arrangement should be made to avoid any accident at site during insitu casting of superstructure. Also in case of foundation if the deep excavation is involved, the quality of surrounded soil be kept in view. There are incidents where few workers got buried in deep excavation due to sudden slide, this should be taken care. In case the well foundation is being attempted using double drum winch care need to be taken during grabbing process. During the diving process the proper coordination needs to be made between the diver and attendant to intimate about the problems if any, for which local signaling arrangements used, this can be finalised at site based on convenience. In case the pneumatic sinking is being used for well foundation, following safety measures, may be observed:

- Accelerate circulation of air
- Slow decompression
- Duplicate and spare equipment
- Illumination inside working chamber
- Signaling arrangement
- Caution about incidental loading

These precautions should be seriously followed to avoid any catastrophes at site. Safety management is also important in case on Staging shuttering for superstructure. There are cases in the past where the collapse of shuttering/staging has led to loss of life. This needs check in before casting the superstructure. In case steel truss is being used as a staging arrangement, design and launching arrangement be thoroughly checked.

F. Documentation Management

Document management during the contract is an art in itself. Proper and systematic management of documents is utmost requirement for department as well as contractor. All the details should be property vetted by both the parties. Better documentation will avoid any disputes during the currency and after completion of contract (i.e. arbitration cases area voided). This needs special attention of the managers of both sides. Most of the cases being dealt by the arbitrator in our country, due to lack of understanding between two parties which, are further affected by improper documentation. In fact better documentation reflect the system of management in any project. Control estimate is required to be prepared annually to assess the job position. This should include work done till date and balance work in terms of money. This will be a guiding principle to progress the job in later period till completion. This practice is a must in all major bridge under construction. As project management has evolved, documentation has become a key skill particularly as projects become more complex and difficult. Organised documentation is the best defence against claims. Documentation that every project manager must have at their disposal are as under:

- Proposal and Bid Estimates – These documents describe how the contractor envisioned the construction of the project and his plan to accomplish the work. It includes information about costs and schedule as well as construction methods.
- Project Schedule - This is one of the most overlooked project records and it can provide the best documentation in a claim situation. The original baseline schedule sets the mark for monitoring the effects of any delays or unforeseen project disruptions.
- Project Change orders – Any variances from the original contractual requirements must be documented and separated from the original scope of work requirements. Daily reports, time sheets, letters of correspondence and meeting minutes or any other documentation discussing agreements made between parties should be readily available.

VI. MAJOR ECOLOGICAL PROBLEMS

A. Deforestation:

The association between deforestation and slope instability has been a subject of considerable research. Deforestation brings about erosion and soil movement is generally accepted, but opinions differ on its impact. So far as "Creeping" slopes are concerned, greater creep velocities are found in slopes covered by trees in the region of Queensland (Australia) than in slopes merely covered by grass in region of rain forests (Brown and Shen, 1975). Prandini et al. (1977)

reported that deforestation leads to loss of mechanical strength imparted by rock system. Reinforcing power of roots is also demonstrated by the results of in situ block shear tests, which show that shear strength increases with increase in root density. At higher altitudes top green layer is very thin and takes hundreds of years to come. A large number of trees along the roadsides are falling down due to road construction. Improper road construction results in soil erosion that may lead to uprooting of large trees and degeneration of lower plants. This way it leads to serious ecological imbalances affecting adversely run-off factors, temperature gradient, surface radiation etc. Due to loss of vegetation, the velocity of run-off also increases that results in soil erosion, hence of soil-fertility.

B. Disturbance of geological strata

Operations like blasting excavation, chipping of mountain slopes to come to desired accessibility, are involved during road construction in hill areas. These operations creates geological disturbance in the mountain body. The blasting operations set dynamic forces causing the movements of slip zones, cracks, fissures and weak planes. The geological havoc caused due to road construction in Kinnaur District in before us. The chronic problems of landslides at Tranda, Chaurah and Kadhra dhank are a few examples.

C. Hill face disturbance:

Natural inclination of hill face is disturbed by road cutting operation. Downhill movement of the landslides material and disposal of excavated mass from road construction degrade and deface the nature. Growth of vegetation is affected by the loss of topsoil that causes ecological imbalances.

D. Drainage Pattern Interruption:

Velocity of run-off at the down hills increases to a very large extent due to construction of bridges and culverts on the road as well as due to cutting for getting proper communication systems. This leads to eroding of banks and is a threat to the existence of trees and vegetation on the hill slopes. Sometimes lakes are formed by accumulation of debris from the excavated material and landslides. Such lakes formed force the water to flow through some other way destroying the side by flora e.g. at Nallah on NH = 22, bridge was washed away thrice in six years because due to debris river was blocked and a temporary lake was formed. Same story was repeated at Pabbar river in Chhawara valley (Rohroo) in 1992, where a big lake (2 miles) was formed and about ten villages were vacated in order to avoid any loss to human life. This lake formed resulted in a loss of large number natural wealth both flora and fauna. This way natural drainage pattern of the area is disturbed by road construction, which sometimes results in flash floods also.

E. Water Resources Disturbance:

Natural water resources get disturbed due to blasting which is used during road construction activities. Moreover, improper disposal of fuel, lubricants used in the process contaminates the surface and ground water.

F. Siltation Problem:

A large quantity of excavated material disposed on the downhill slopes is carried by the river that gets accumulated

in the dams and reservoirs and reduce their life-span e.g. siltation rate of Bhakhra Dam reservoir is very large which is due to large scale road construction in Sutlej catchment.

G. Destruction to Flora and Fauna:

Wild life gets disturbed due to blasting, hauling of machineries, shriveling sound of road rollers and noise of moving vehicles on the up-gradient. Destruction of key habitats such as resting sites, hollow trees, feeding and breeding grounds occurs due to road constructions. Some of the flora and fauna gets destroyed out right due to intrusion into forest for road construction.

H. Pollution:

Tremendous pollution is created due to accumulation of debris downhill. Moreover, heating of bitumen through hot mix plants produces a large number of air pollutants like oxides of sulphur, nitrogen and carbon. Long chain aliphatic hydrocarbons and aromatic compounds are also the byproducts of this heating process, which are having carcinogenic property (Cancer producing) and special precautions must be taken for protecting the labourers working under such conditions on the road construction site. Surrounding temperature gets increased and atmospheric humidity is lowered due to movements of machineries and vehicles, altering the physiological processes of the plants and thereby affecting their growth pattern. The alterations in the surrounding conditions cause interference of micro-organism life in the soil.

I. Destruction of Medicinal Wealth:

In the hill areas of Himachal Pradesh out of 3000 species of identifies plants, over 500 species possess various kinds of medicinal properties. Hundreds of plants have ethno botanical importance. There are about 150 species of aromatic plants used in different kinds of cosmetics and having different medicinal properties. But due to improper planning in road construction and processes involved during road construction, the natural wealth gets destroyed costing crores of rupees in spite of protecting the atmosphere from pollution.

VII. PROTECTIVE MEASURES

In order to maintain balance between the road construction activities and environment certain protective measures have to be taken. Some of these measures are as follows:

A. Environment impact assessment:

Before starting the road construction operation, environmentalists must be consulted in order to avoid any ecological imbalance.

B. Geological Investigation:

A geologist must be incorporated in the road construction work. Blasting and chipping of mountain slopes must be done under his instructions in order to avoid any geological havoc.

C. State of Wildlife:

During the road construction loss to flora and fauna must be minimum. It should not be disturbed. An environmentalist must be consulted prior to road construction work.

D. Avoidance of unstable and fissure zones:

Roads should not be constructed in loose soil and where erosion chances are more. In such cases the help of a soil Engineer must be taken, before starting any such activities. Least disturbance to natural streams and gradients: Natural face of the hill must be least disturbed while constructing the roads. Only the required land must be used for the purpose.

E. Restriction on Reserve Forests:

Road construction activities must be minimum on reserve forests in order to avoid any disturbance to natural wealth. This will help in maintaining the ecological balance.

F. Judicial way of doing work:

While cutting and disposing the debris special care must be taken so that there is no soil erosion and loss to flora and fauna.

G. Minimum blasting operations:

Blasting practice during road construction must be to the minimum extent in order to avoid any dynamic forces causing movements of slip zones, cracks, fissures and weak planes.

H. Half tunneling must be restored:

In case of vertical rocky slopes half-tunneling must be restored.

I. Ropeway Technique:

In case of less densely thick population ropeway must be installed instead of going for road construction. This will provide protection to soil erosion, wild life and environment.

J. Suitable drainage system:

Along the entire side of the road, a suitable drainage system must be provided so as to avoid any flash flood, soil erosion, damage to vegetation etc.

K. Restoration of Natural Springs and Waterways:

Natural springs and water resources must not be disturbed during road construction process, otherwise it will be a great challenge to the nature.

L. Rebuilding of Environment:

- 1) On suitable points, places must be provided that may act as scenic spots to the users.
- 2) Programme of social forestry must be taken upto the root level. The wastelands must be garlanded with trees, and valuable herbs and shrubs. The best example of social forestry is found in china where even single inch of wasteland is not left without plantation. Debris obtained during road cuttings must be accumulated at some appropriate place and plantation must be done on the same. This plantation will help in retaining the natural environment.
- 3) Plantation must be done along the banks of rivers, nallaha etc. in order to avoid any further cutting of soil and to protect the water reservoirs and dams from more siltation.
- 4) Small water tanks along with the proper drainage system must be constructed along the roadsides in order to

protect both flora and fauna. Roadsides must be planted at war-level so as to give the best example of afforestation.

VIII. CONCLUSION

Construction management basically is a tool to complete the project effectively within fixed amount but in less time. Manager should have knowledge sequence of all the activities. Decision making for both sides the contractor and the client needs to be fast and time bound otherwise the project will get delayed which will have cost overrun. Control in form of reviewing monitoring has a catalyst effect to boost the progress.

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